RAYTHEON

TECHNICAL INFORMATION SERVICE

# Technical Information

# CK 6872

## RELIABLE SUBMINIATURE PENTODE

The CK6872 is a heater-cathode type semi-remote-cutoff pentode of subminiature construction capable of operation in the VHF region. It is applicable to amplifier service in which it is desirable to apply automatic gain control. This tube is characterized by long life and stable performance. It is designed for service where severe conditions of high temperature and mechanical shock or vibration are encountered. A separate terminal connection is provided for Grid #3, which under self-bias conditions can be connected directly to ground permitting the cathode by-pass capacitor to be omitted for lower grid loading. The flexible terminal leads may be soldered or welded directly to the terminals of circuit components without the use of sockets. Standard inline subminiature sockets may be used by cutting the leads to a suitable length.

MECHANICAL RATINGS: (Absolute Maximum)

| | | |
|---|---|---|
| Impact Acceleration (Shock) | 450 | G |
| Uniform Acceleration (Centrifuge Test) | 1000 | G |
| Fatigue (Vibrational Acceleration for Extended Periods) | 2.5 | G |
| Bulb Temperature | 220 | °C |
| Altitude | 60,000 | Ft |

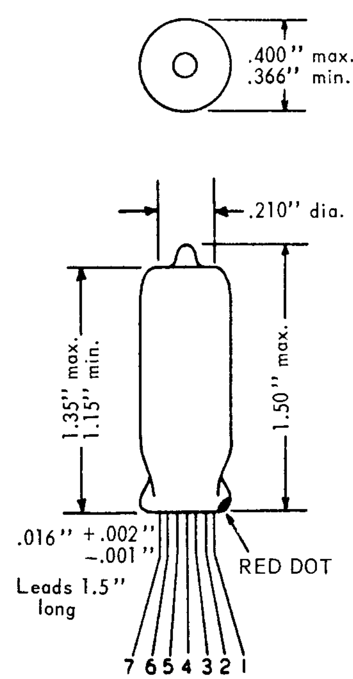
## ELECTRICAL DATA

| Ratings and Normal Operation: | MIL-E-1 Symbol | Test Limit or Design Minimum | Normal Operation | Normal Test Conditions | Test Limit or Design Maximum | MIL-E-1 Units |
|---|---|---|---|---|---|---|
| | | | Ratings | | | |
| Heater Voltage | Ef: | 5.7 | 6.3 | 6.3 | 6.9 | V |
| Plate Voltage | Eb: | --- | 120 | 120 | 165 | Vdc |
| Grid #1 Voltage | Ec1: | -55 | 0 | 0 | --- | Vdc |
| Grid #2 Voltage | Ec2: | --- | 120 | 120 | 155 | Vdc |
| Grid #3 Voltage | Ec3: | --- | 0 | 0 | 0 | Vdc |
| Cathode Resistance | Rk: | --- | 200 | 200 | --- | ohms |
| Plate Dissipation | Pp: | --- | 0.95 | --- | 1.1 | W |
| Grid #2 Dissipation | Pg2: | --- | 0.32 | --- | 0.4 | W |
| Grid #1 Circuit Resistance | Rg: | --- | 1.0 | --- | 1.2 | Meg. |
| Heater-Cathode Voltage | Ehk: | --- | 100 | --- | 200 | V |
| Cathode Current | Ik: | --- | --- | --- | 16.5 | mAdc |

### MECHANICAL DATA

| | |
|---|---|
| ENVELOPE | Glass T-3 |
| OUTLINE | (8-7) |
| BASE | Flat Press, 7 leads in line spacing 0.048" center to center |
| CATHODE | Coated unipotential |
| MOUNTING POSITION | Any |

### PHYSICAL DIMENSIONS




### TERMINAL CONNECTIONS

| | |
|---|---|
| Lead 1 | Plate |
| Lead 2 | Grid #2 |
| Lead 3 | Heater |
| Lead 4 | Heater |
| Lead 5 | Grid #3 |
| Lead 6 | Cathode |
| Lead 7 | Grid #1 |

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## ELECTRICAL DATA (cont'd)

| Ratings and Normal Operation | MIL-E-1 Symbol | Test Limit or Design Minimum | Normal Operation | Normal Test Conditions | Test Limit or Design Maximum | MIL-E-1 Units |
|---|---|---|---|---|---|---|
| | | | Tests | | | |
| Heater Current | If: | 183 | 200 | --- | 217 | mA |
| Plate Current (1) | Ib: | 5.7 | 7.75 | --- | 9.8 | mAdc |
| Screen Grid Current | Ic2: | 1.7 | 2.7 | --- | 3.7 | mAdc |
| Transconductance (1) | Sm: | 3400 | 4100 | --- | 4800 | μmhos |
| Transconductance (2) Ef = 5.5 V | $\Delta_{Ef}$Sm: | --- | --- | --- | 10 | % |
| Transconductance (3) Ec1 = −14 Vdc | Sm: | --- | --- | --- | 125 | μmhos |
| Plate Resistance | rp: | 0.15 | 0.34 | --- | --- | Meg. |
| Vibration Rp = 10,000; f = 40 cps; G = 15 | Ep: | --- | --- | --- | 50 | mVac |
| Capacitance (Note A) | Cgp: | --- | --- | --- | 0.03 | pf |
| Capacitance (Note A) | Cin: | 4.2 | 5.0 | --- | 5.8 | pf |
| Capacitance (Note A) | Cout: | 2.9 | 3.5 | --- | 4.15 | pf |
| Tube Operation Time (Note B) | t: | --- | --- | --- | 20 | seconds |

## SPECIAL TESTS AND RATINGS TO INSURE RELIABILITY

Randomly selected statistical samples are subjected to the following tests:

**Shock Test –** 450 G. 30° hammer angle in Navy high impact shock machine. Sample subjected to twenty impact accelerations, five impact accelerations in each of four different positions.

**Fatigue Test –** 2.5 G. Sample subjected to vibrational acceleration of 2.5 G for 96 hours (32 hours in each of three positions). The sinusoidal vibration is applied at a fixed frequency between 25 and 60 cycles per second.

**Glass Strain –** A sample is subjected to a forty eight hour holding period at room temperature. The sample is immersed in water at 97–100°C for 15 seconds and immediately immersed in water at not more than 5°C. The sample is then dried at room temperature for 48 hours and inspected for evidence of air leaks.

**Heater-Cycling Life Test –** A sample is subjected to 2000 on-off heater cycles at the following conditions. Ef = 7.5 V; Ehk = + 135 Vdc and other elements floating. At the conclusion of this test the tubes will not show open heater or cathode circuits and meet a maximum Ihk leakage limit of 20 μAdc.

| | |
|---|---|
| Stability Life Test – | Sample is operated for one hour to evaluate initial electrical stability ($\Delta_t$ Sm < 10%). |
| Survival Rate Life Test – | Sample is operated one hundred hours to evaluate inoperatives and early electrical stability. |
| Intermittent Life Test – | 1000 hours. Sample is operated with minimum Envelope Temperature of 220°C. |
| Altitude – | Sample is subjected to a pressure of 55 ± 5 mm Hg (60,000 ft.) to assure freedom from flashover or corona at the leads of the tube. Voltage = 300 Vac. |

## APPLICATION NOTES

Note A: With a cylindrical shield (0.405" I.D. – 1-7/8" long) connected to lead 6.

Note B: Tube operation time is the time in seconds required for the plate current to reach at least 90% of the permanent 3 minute plate current.

CAUTION – – To Electronic Equipment Design Engineers. Special attention should be given to the temperature at which the tubes are to be operated. Reliability will be seriously impaired if maximum bulb temperature is exceeded. The life expectancy may be reduced if conditions other than those specified for life test are imposed on the tube and will be reduced appreciably if maximum ratings are exceeded. Both reliability and performance will be jeopardized if filament voltage ratings are exceeded. Life and reliability of performance are closely related to the degree that regulation of the heater voltage is maintained at its center rated value.

RAYTHEON

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## RELIABLE SUBMINIATURE PENTODE

### ACCEPTANCE CRITERIA

The following tests shall be performed:

For the purpose of inspection, use applicable reliable paragraphs of Specification MIL-E-1.

For miscellaneous requirements, see 3.6.

### TEST CONDITIONS

Ef = 6.3 V
Eb = 120 Vdc
Ec2 = 120 Vdc

Ec1 = Ec3 = 0 Vdc
Rk = 200 ohms

| Ref. | Test | Conditions | AQL % | Insp. Level or Code | Symbol | Limits, See Note 4 | | | | | | Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Min. | LAL | Bogie | UAL | Max. | ALD | |
| | **QUALIFICATION APPROVAL TESTS** | | | | | | | | | | | |
| 3.1 | Qualification Approval: | Required, Note 21 | --- | --- | | | | | | | | |
| 3.7 | Marking: | Note 19: | --- | --- | | | | | | | | |
| --- | Cathode: | Coated unipotential: | --- | --- | | | | | | | | |
| 3.4.3 | Base Connections: | | --- | --- | | | | | | | | |
| 4.9.20.3 | Vibration (1): | Rp=10,000; CK=1000µf: | --- | --- | Ep: | --- | --- | --- | --- | 50 | --- | mVac |
| | **MEASUREMENTS ACCEPTANCE TESTS, PART 1, NOTE 3** | | | | | | | | | | | |
| 4.10.9 | Heater Current: | | --- | --- | If: | --- | 192 | 200 | 208 | --- | 16 | mA |
| 4.10.8 | Heater Current: | | 0.65 | II | If: | 183 | --- | --- | --- | 217 | --- | mA |
| 4.10.15 | Heater-Cathode Leakage: | Ehk=+100 Vdc | 0.65 | II | Ihk: | --- | --- | --- | --- | 5.0 | --- | µAdc |
| | | Ehk=-100 Vdc | | | Ihk: | --- | --- | --- | --- | 5.0 | --- | µAdc |
| 4.10.6.1 | Grid Current: | Rg1=1.0 Meg. | 0.65 | II | Ic1: | 0 | --- | --- | --- | -0.3 | --- | µAdc |
| 4.10.4.1 | Plate Current (1): | | --- | --- | Ib: | --- | 6.9 | 7.75 | 8.6 | --- | 2.6 | mAdc |
| 4.10.4.1 | Plate Current (1): | | 0.65 | II | Ib: | 5.7 | --- | --- | --- | 9.8 | --- | mAdc |
| 4.10.4.3 | Screen Grid Current: | | 0.65 | II | Ic2: | 1.7 | --- | --- | --- | 3.7 | --- | mAdc |
| 4.10.9 | Transconductance (1): | | --- | --- | Sm: | --- | 3800 | 4100 | 4400 | --- | 800 | µmhos |
| 4.10.9 | Transconductance (1): | | 0.65 | II | Sm: | 3400 | --- | --- | --- | 4800 | --- | µmhos |
| 4.7.5 | Continuity and Shorts (Inoperatives): | | 0.40 | II | --- | --- | --- | --- | --- | --- | --- | --- |
| 4.9.1 | Mechanical: | Envelope outline No. (8-7) | | | | | | | | | | |
| | **MEASUREMENTS ACCEPTANCE TESTS, PART 2** | | | | | | | | | | | |
| 4.8.2 | Insulation of Electrodes: | g1-all | 2.5 | L6 | R: | 100 | --- | --- | --- | --- | --- | Meg |
| | | p-all | | | R: | 100 | --- | --- | --- | --- | --- | Meg |
| 4.10.9 | Transconductance (2): | Ef=5.5 V; Note 1 | 2.5 | I | ΔSm: Ef: | --- | --- | --- | --- | 10 | --- | % |

## RELIABLE SUBMINIATURE PENTODE

| Ref. | Test | Conditions | AQL % | Insp. Level or Code | Symbol | Limits: Min. | LAL | Bogie | UAL | Max. | ALD | Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **MEASUREMENTS ACCEPTANCE TESTS, PART 2 (Cont'd.)** | | | | | | | | | | | |
| 4.10.9 | Transconductance (3): | Ec1=−14 Vdc; Rk=0 | 2.5 | I | Sm: | 5 | --- | --- | --- | 125 | --- | μmhos |
| 4.10.6.2 | Grid Emission: | Note 18 | 6.5 | L6 | Ic1: | 0 | --- | --- | --- | −0.5 | --- | μAdc |
| 4.10.3.2 | AF Noise: | Esig=70mVac; Ecc2=25Vdc; Rg1=0.1 Meg; Rg2=1000 ohms; RK=3000 ohms; Rp=0.15 Meg; CK=1000μf Note 20 | 2.5 | I | | --- | --- | --- | --- | | --- | |
| 4.10.10 | Plate Resistance: | | 6.5 | L6 | rp: | 0.15 | --- | --- | --- | --- | --- | Meg |
| 4.10.14 | Capacitance: | 0.405 in. dia shield | 6.5 | Code E | Cg1p: | --- | --- | --- | --- | 0.03 | --- | μμf |
| | | 0.405 in. dia shield | | | Cin: | 4.2 | --- | --- | --- | 5.8 | --- | μμf |
| | | 0.405 in. dia shield | | | Cout: | 2.9 | --- | --- | --- | 4.15 | --- | μμf |
| 4.9.12.1 | Low Pressure Voltage Breakdown: | Pressure=55 ±5 mm Hg. Voltage=300 Vac | 6.5 | Note 5 | | --- | --- | --- | --- | --- | --- | |
| --- | Operation Time: | t=20 sec; Note 6 | 4.0 | L6 | Ib(1): | 90 | --- | --- | --- | 110 | --- | % |
| 4.9.19.1 | Vibration (2): | Rp=10,000; Ck=1000μf F=40 cps; G=15 | 2.5 | I | Ep: | --- | --- | --- | --- | 50 | --- | mVac |
| | **DEGRADATION RATE ACCEPTANCE TESTS, NOTE 7** | | | | | | | | | | | |
| 4.9.5.3 | Subminiature Lead Fatigue: | Note 8 | 2.5 | Code C | | 4 | --- | --- | --- | --- | --- | arcs |
| 4.9.20.5 | Shock: | Hammer angle=30° Ehk=+100 Vdc; Notes 2 and 9 | | --- | --- | --- | --- | --- | --- | --- | --- | |
| 4.9.20.6 | Fatigue: | G=2.5; fixed frequency F=25 min., 60 max. | 6.5 | Note 5 | | --- | --- | --- | --- | --- | --- | |
| --- | Post Shock and Fatigue Test End Points: | Vibration (2) | --- | --- | Ep: | --- | --- | --- | --- | 100 | --- | mVac |
| | | Heater cathode leakage Ehk=+100 Vdc | --- | --- | Ihk: | --- | --- | --- | --- | 20 | --- | μAdc |
| | | Ehk=−100 Vdc | --- | --- | Ihk: | --- | --- | --- | --- | 20 | --- | μAdc |
| | | Change in transconductance (1) of individual tubes | --- | --- | ΔSm: t | --- | --- | --- | --- | 20 | --- | % |
| | **DEGRADATION RATE ACCEPTANCE TESTS, NOTE 8** | | | | | | | | | | | |
| 4.9.6.3 | Glass Strain: | | 6.5 | I | | --- | --- | --- | --- | --- | --- | |

| Ref. | Test | Conditions | AQL % | Insp. Level or Code | Allowable Defectives per Characteristics: First Sample | Allowable Defectives per Characteristics: Combined Samples | Symbol | LIMITS: Min. | LIMITS: Max. | Units |
|---|---|---|---|---|---|---|---|---|---|---|
| | **ACCEPTANCE LIFE TESTS, NOTE 7** | | | | | | | | | |
| 4.11.7 | Heater Cycling Life Test: | Ef=7.5 V; 1 min. on, 1 min. off; Ehk=140 Vac; Ec1=Ec2=Ec3=Eb=0; Note 10 | | | --- | --- | | --- | --- | |
| 4.11.4 | Heater Cycling Life Test End Points: | Heater-cathode Leakage | | | | | | | | |
| | | Ehk=+100 Vdc | --- | --- | --- | --- | Ihk: | --- | 20 | μAdc |
| | | Ehk=−100 Vdc | --- | --- | --- | --- | Ihk: | --- | 20 | μAdc |
| 4.11.3.1 | Stability Life Test (1 Hour): | Ehk=+200 Vdc; Rg1=1.0 Meg; TA=Room; Note 11 | 1.0 | Code I | --- | --- | | --- | --- | |
| 4.11.4 | Stability Life Test End Points: | Change in transconductance (1) of individual tubes | --- | --- | --- | --- | $\Delta$Sm: t | --- | 10 | % |
| 4.11.3.1 | Survival Rate Life Test (100 Hours): | Stability life test conditions or equivalent; TA=Room; Notes 12 and 13 | --- | II | --- | --- | | --- | --- | |
| 4.11.4 | Survival Rate Life Test End Points: | Continuity and shorts (Inoperatives) | 0.65 | --- | --- | --- | --- | --- | --- | |
| | | Transconductance (1) | 1.0 | --- | --- | --- | $\Delta$Sm: t | 3000 | --- | μmhos |
| 4.11.3.1 | Intermittent Life Tests: | Stability life test conditions T Bulb=220°C. min. Notes 14 and 15 | | | | | | | | |
| 4.11.4 | Intermittent Life Test End Points (500 Hours): | Note 16 | | | | | | | | |
| | | Inoperative; Note 17 | --- | --- | 1 | 3 | --- | --- | --- | --- |
| | | Grid current (1) | --- | --- | 1 | 3 | Ic1: | --- | −0.8 | μAdc |
| | | Heater current | --- | --- | 1 | 3 | If: | 180 | 220 | mA |
| | | Change in transconductance (1) of individual tubes | --- | --- | 1 | 3 | $\Delta$Sm: t | --- | 20 | % |

# RELIABLE SUBMINIATURE PENTODE

| Ref. | Test | Conditions | AQL % | Insp. Level or Code | Allowable Defectives per Characteristics First Sample | Allowable Defectives per Characteristics Combined Samples | Symbol | LIMITS Min. | LIMITS Max. | Units |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Transconductance (2) | --- | --- | 2 | 5 | ΔSm: Ef: | --- | 15 | % |
| | | Heater-cathode leakage<br>Ehk=+100 Vdc<br>Ehk=−100 Vdc | --- | --- | 2 | 5 | Ihk:<br>Ihk: | ---<br>--- | 10<br>10 | μAdc<br>μAdc |
| | | Insulation of electrodes<br>g1-all<br>p-all | --- | --- | 2 | 5 | R:<br>R: | 50<br>50 | ---<br>--- | Meg<br>Meg |
| | | Transconductance (1)<br>Average change | --- | --- | --- | --- | Avg ΔSm: t | --- | 15 | % |
| | | Total defectives | --- | --- | 4 | 8 | --- | --- | --- | --- |
| 4.11.4 | Intermittent Life Test End Points (1000 Hours): | Note 16 | | | | | | | | |
| | | Inoperatives; Note 17 | --- | --- | 2 | 5 | --- | --- | --- | --- |
| | | Grid current (1) | --- | --- | 2 | 5 | Ic1: | --- | −1.0 | μAdc |
| | | Heater current | --- | --- | 2 | 5 | If: | 190 | 220 | mA |
| | | Change in transconductance (1) of individual tubes | --- | --- | 2 | 5 | ΔSm: t | --- | 30 | % |
| | | Heater-cathode leakage<br>Ehk=+100 Vdc<br>Ehk=−100 Vdc | ---<br>--- | ---<br>--- | 2 | 5 | Ihk:<br>Ihk: | ---<br>--- | 15<br>15 | μAdc<br>μAdc |
| | | Total defectives | --- | --- | 5 | 10 | --- | --- | --- | --- |
| 4.9.18.1.1 | Container Drop | Required | | | | | | | | |
| 5.1 | Preparation for Delivery | (d) Package group 1; container size D; container drop test in accordance with Specification MIL–P–75 | | | | | | | | |

Note 1: Transconductance (2) is the percent change in Transconductance (1) of an individual tube resulting from the change in Ef.

Note 2: A grid resistor of 0.1 megohm shall be added; however, this resistor will not be used when a thyratron-type short indicator is employed.

Note 3: The AQL for the combined defectives for attributes in Measurements Acceptance Tests, Part 1, excluding inoperatives and mechanical shall be one percent. A tube having one or more defects shall be counted as one defective. Standard MIL–STD–105, inspection level II shall apply.

Note 4: Variables sampling procedure. – See paragraph 5.3.3 to 5.3.3.4, inclusive, of the Inspection Instructions for Electron Tubes.

Note 5: This test shall be conducted on the initial lot and thereafter on a lot approximately every 30 days. Once a lot has passed, the 30-day rule shall apply. In the event of lot failure, the lot shall be rejected and the succeeding lots shall be subjected to this test until a lot passes. Standard MIL–STD–105, sample size code letter F shall apply.

Note 6: Operation time is the time in seconds required for the plate current to attain a value within plus or minus 10 percent of the 3-minute plate current (1) value when measured at the test conditions specified for plate current (1). No preheating is allowed prior to this test.

Note 7: Destructive tests. – Tubes subjected to the following destructive tests will not be accepted under this specification:

4.9.5.3 Subminiature lead fatigue
4.9.20.5 Shock
4.9.20.6 Fatigue
4.11.7 Heater-cycling life test
4.11.3.1 Intermittent life test

Note 8: When a manufacturer submits tubes for qualification approval, five extra tubes shall be submitted for lead fatigue testing. These may be electrical rejects.

Note 9: Leads may be clipped for application of voltages during impact.

Note 10: The no-load to steady state full load regulation of the heater voltage supply shall be not more than 3.0 percent. This test shall be made on a lot by lot basis. A failure or defect shall consist of an open heater, open cathode circuit, heater-cathode short, or heater-cathode leakage in excess of the specified heater-cycling life test end point limit.

Note 11: Stability life test. – The sampling and testing procedure for this test shall be in accordance with paragraphs 5.3.4.1(a) to 5.3.4.1(g), inclusive, of the Inspection Instructions for Electron Tubes.

Note 12: Survival rate life test. – The sampling and testing procedure for this test shall be defined in paragraphs 5.3.4.2 to 5.3.4.2.4, inclusive, of the Inspection Instructions for Electron Tubes.

Note 13: For survival rate life test, the equivalent stability life test conditions shall be as defined in paragraph 5.3.4.2.5 of the Inspection Instructions for Electron Tubes.

Note 14: Intermittent life tests. – Sampling and acceptance procedures for these tests shall be as defined in paragraphs 5.3.4.3 (a) to 5.3.4.3 (i), inclusive, of the Inspection Instructions for Electron Tubes, except that the following subparagraph shall be added to 5.3.4.3 (e); (4) The life test samples from the first lot accepted each month shall continue on life test for an additional 500 hours (1000 hours total life test time). Failure of this sample to meet the 1000-hour life test end points shall result in loss of eligibility for reduced hours testing.

Note 15: Envelope temperature is defined as the highest temperature indicated when using a thermocouple of #40 BS or smaller diameter elements welded to a ring of 0.025 inch diameter phosphor bronze in contact with the envelope. Envelope temperature requirement will be satisfied if tube, having bogie Ib (±5 percent) under normal test conditions, is determined to operate at minimum specified temperature at any position in the life test rack.

Note 16: Order for evaluation of life test defects. – See paragraph 5.3.4.4 of the Inspection Instructions for Electron Tubes.

Note 17: An inoperative as referenced in life test is defined as a tube having one or more of the following defects: Discontinuity (see 4.7.1 of Specification MIL–E–1), shorts (see 4.7.2 of Specification MIL–E–1), air leaks (see 4.7.6 of Specification MIL–E–1).

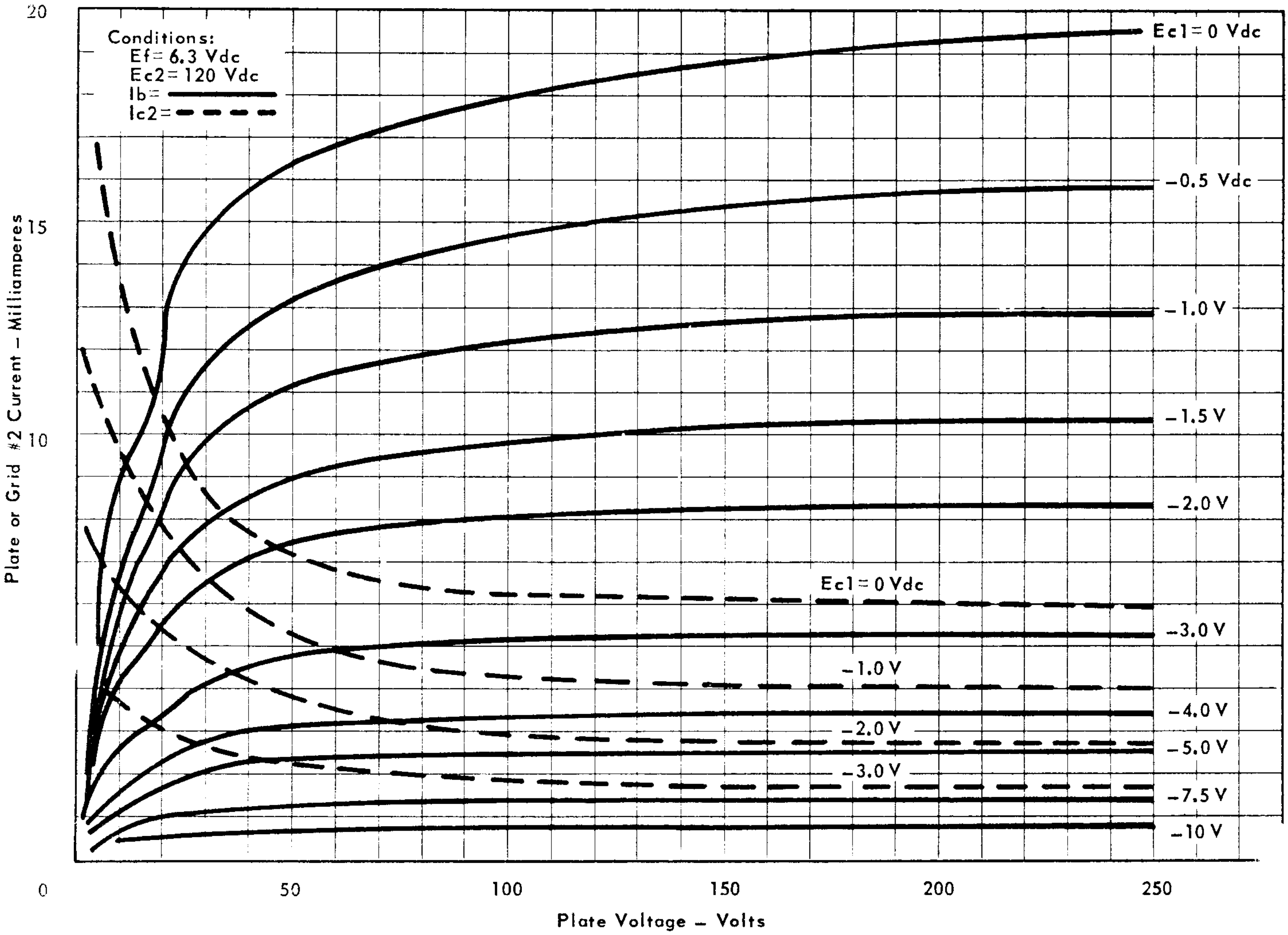
Note 18: Prior to this test, the tube shall be preheated a minimum of 5 minutes at the conditions indicated hereinafter. Three minute test is not permitted. Test at preheat conditions, except Ec1 = –15Vdc; within 3 seconds after preheating. Grid emission shall be the last test performed on the sample selected for the grid emission test.

| Ef | Ec1 | Ec2 | Ec3 | Eb | Rk | Rg1 |
|---|---|---|---|---|---|---|
| V | Vdc | Vdc | Vdc | Vdc | ohms | Meg |
| 7.5 | 0 | 120 | 0 | 120 | 200 | 1.0 |

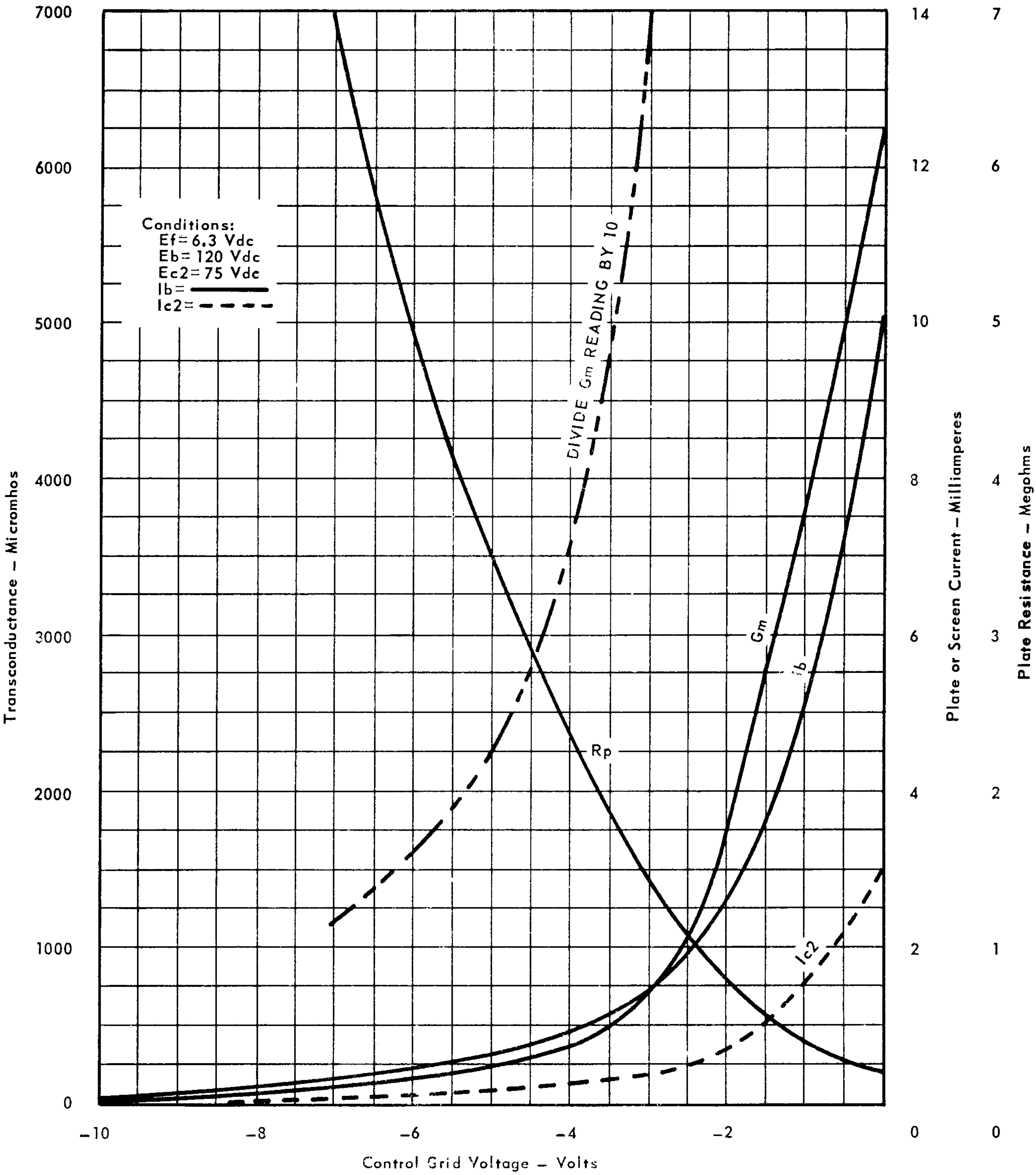
Note 19: Tubes shall be marked "USN–6872".

Note 20: The rejection level shall be set at the VU meter reading obtained during calibration.

AVERAGE PLATE CHARACTERISTICS



AVERAGE TRANSFER CHARACTERISTICS



RELIABLE SUBMINIATURE PENTODE

AVERAGE TRANSFER CHARACTERISTICS

